DRAFT
Initial Findings Report Emission Reduction Strategies for the New York/New Jersey Harbor Navigation Project

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Prepared for:

United States Army Corps of Engineers, New York District
The Port Authority of New York & New Jersey

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EXECUTIVE SUMMARY

Killam Associates has retained Starcrest Consulting Group, LLC to perform a review of diesel engine emission control strategies on behalf of the United States. Army Corps of Engineers and the Port Authority of New York & New Jersey. Killam has also retained Allee King Rosen & Fleming, Inc. to examine emission credit options. Both of these reviews are specifically focused on potential emission issues associated with dredging and associated activities proposed for the 50-foot deepening project within seven channels of the New York/New Jersey Harbor.

This draft report represents an initial compilation of the information gained through these review efforts. This document is an initial findings report, which will be updated and finalized over the next six months in conjunction with a comprehensive marine vessel emissions inventory. In particular, additional review and investigation will be conducted over the next six months to determine the most promising emission reduction strategies for this project. The final emission reduction strategies report will serve as the feasibility baseline report that will be updated on a regular basis during the course of the Harbor Navigation Project.

The main impetus for seeking ways to reduce emissions from the project is the requirement to show "general conformity" with the New York and New Jersey plans to meet ambient air quality standards. This requirement resulted from the Clean Air Act Amendments of 1990, and has been promulgated in the Code of Federal Regulations (CFR) at 40 CFR 93.158. General conformity requires that federal actions, such as providing funding and/or issuing permits, do not interfere with states' efforts to attain or maintain ambient air quality standards. In addition to conformity, concern over particulate emissions from diesel engines has lead the United States. Environmental Protection Agency to request an evaluation of potential means of controlling or reducing diesel particulate emissions.

Three general topics are addressed in this report:

- Use of emission control technologies to reduce emissions from existing equipment;
- Operational changes to lower emissions; and,
- Use of emission credits to offset project emissions.

The report discusses several promising emission control technologies being developed for the types of diesel engines to be used in the 50-foot deepening project. While there are no mature bolt-on technologies for the control of NO_x emissions (the primary pollutant of concern with regard to attaining ambient ozone standards), there are devices that can effectively control particulate emissions as well as carbon monoxide and volatile organic compounds. One currently available, although not verified by the United States Environmental Protection Agency, NO_x emission reduction technology discussed in the report is the use of diesel/water fuel emulsions. In addition, there are NO_x control devices under development that have the potential to be useful in the future.

The report also discusses operational changes for reducing emissions, such as replacing old engines with new engines that meet the latest emission standards, or using electric motors in place of diesel engines. These options can result in emission reductions of all pollutants of concern with regard to this project.

A third mechanism to reduce the emissions impacts of the project would be to generate or purchase emission credits that would offset the increases produced by the project. This option would be the least technologically challenging of the options evaluated. The report summarizes the trading mechanisms in place in New Jersey and New York, and discusses the issues surrounding the use of credits for the 50-foot deepening project.

INTRODUCTION

Killam Associates (Killam) has retained Starcrest Consulting Group, LLC. (Starcrest) to perform a review of diesel engine emission control strategies on behalf of the United States Army Corps of Engineers (USACE) and the Port Authority of New York & New Jersey (PANYNJ), Killam has also retained AKRF Inc. (AKRF) to examine emission credit options. Both of these reviews are specifically focused on potential emission issues associated with dredging and associated activities proposed for the 50-foot deepening project within seven channels of the New York/New Jersey Harbor (NYNJH).

This effort was undertaken in response to a scope of work included in a draft agreement, regarding general conformity, developed by the USACE and PANYNJ to fulfill requirements of the New Jersey Department of Environmental Protection (NJDEP), the New York State Department of Environmental Conservation (NYSDEC), and the United States Environmental Protection Agency (USEPA) Region 2. The draft agreement was prepared subsequent to discussions between the above referenced parties during a 30 November 2001 meeting, when it was discussed that the proposed dredging project should be evaluated with regard to the use of emerging emission reduction technologies.

Please note that the regulatory driver forming the basis of the draft agreement is the federal requirement of General Conformity (40CFR§93.158), which is triggered by the USACE engaging in, and providing financial assistance for, the New York and New Jersey Harbor Navigation Project, as described in the New York and New Jersey Harbor Navigation Feasibility Study dated December 1999. The effort described herein identifies potential emission reduction strategies to help ensure that any increase in diesel emissions would not adversely impact the air quality State Implementation Plans (SIPs) for both New York and New Jersey.

OBJECTIVE

The objective of this report is to provide an initial overview of the feasibility of several emission reduction strategies that could be implemented to reduce emissions during the Harbor Navigation Project (HNP). As per the above-mentioned draft agreement among all parties, an initial review and examination of the following strategies has been undertaken and is described herein:

- Use of Emission Control Technologies (ECTs): retrofits or technology solutions for existing dredge and towboat engines, exhaust retrofits and filters for particulate matter, and low sulfur fuels or fuel additives in project dredge engines (See Section A);
- Operational changes: engine re-powering, electrification of dredges, and/or alternative fuels (See Section B)**; and,**
- Use of emission credits to offset project emissions (See Section C).

This draft report represents an initial compilation of the information gained through these review efforts and responds to the first requirement of the draft agreement. Please be aware, this document is only an ***initial*** findings report, which will be updated and finalized over the next six months in conjunction with the comprehensive marine vessel emissions inventory. In particular, additional review and investigation will be conducted over the next six months to determine the most promising emission reduction strategies for this project. The final emission reduction strategies report will serve as the feasibility baseline report that will be updated on a regular basis during the course of the HNP.

The draft report discusses the three general strategies in the order listed above, with each strategy section being subdivided into topics relevant to the strategy.

BACKGROUND ON DIESEL ENGINE EMISSIONS

The following two sections (HNP Emission Source Types and Pollutants of Concern) provide background information pertaining to emission source types and pollutants of concern associated with construction of the HNP. These sections are important since emission control technologies are generally designed for specific source types, and since they target reductions of specific pollutants.

HNP EMISSION SOURCE TYPES

The major emission source types associated with the HNP are nonroad mobile sources with large and medium sized diesel engines that are on either marine or land-based equipment, such as dredges, towboats, pushboats, crew boats, excavators, and off-road trucks. Unlike industrial diesel engines, which mainly operate under constant loads, these non-road engines have varying load profiles during their normal duty cycles that are transient. This means that the load that is applied to the engines is not constant or steady throughout normal operations. This operating characteristic has important ramifications for emission control systems because of the varying exhaust temperatures and flow rates that occur under transient load conditions.

Dredges and towboats are responsible for a majority of the projected HNP emissions. Engines on these vessels are mainly Category 2 marine engines or land-based engines (adapted for use on marine vessels) greater than 750 horsepower. This presents some limitation for emission control systems due to sheer engine size, because most current development work on mobile diesel engine emission controls is focused on smaller engines such as those that power buses or freight-hauling trucks. However, since these engines are so large, they also present opportunities to make large reductions in emissions. Smaller engines such as those used for auxiliary power or those producing less than 750 horsepower have a smaller impact on overall emissions.

POLLUTANTS OF CONCERN

The New York-New Jersey area is a severe ozone nonattainment area, so the ozone precursors (volatile organic compounds (VOC) and oxides of nitrogen (NO_x)) are key pollutants of concern. Given the nature of diesel engines, however, VOC is not as critical as NO_x, due to the diesel engine's inherently low emissions of VOC. Carbon monoxide (CO) is another critical pollutant because of a shared New York – New Jersey CO nonattainment area (this is currently being proposed for redesignation to attainment status).

A portion of lower New York State has been designated as a particulate matter (PM-10) nonattainment area. In addition, diesel smoke (which is primarily PM-10) is a public health concern being studied in California as well as by the USEPA, based on its probable toxicity. Therefore PM-10 also is considered a pollutant of concern, and federal regulators have requested an assessment of potential PM-10 reductions for the HNP. This assessment is being performed even though it is not formally required by Federal Conformity regulations.

EMISSION REDUCTION STRATEGIES

After a review of potential measures for reducing emissions, three different emission reduction strategies have been identified for potential use during the HNP, and are described below. These three strategies are emission control technologies, operational changes (i.e., engine repowering/electrification), and emission credit options. Emission control technologies modify or add to an existing engine to lower emissions, such as by using an exhaust retrofit kit or a cleaner fuel. Operational changes relate to engine repowering, in which the entire engine is replaced with a new unit. Emission credits are documented emission reductions, unrelated to the project, that would either be generated by the PANYNJ or the USACE, or be obtained through trade or purchase from a third party.

A. EMISSION CONTROL TECHNOLOGIES (ECTS)

There are two major categories of ECTs: 1) diesel retrofit technologies and 2) fuel-based technologies. Each of these categories consists of available or emerging technologies that can be used with mobile sources. However, the vendor's claims of emission reductions must be proven to assure that actual emission reductions are real. The primary method of claiming emission reductions in a SIP is for the ECT to be "verified" as effective by USEPA. In particular, ECTs for mobile nonroad sources must be verified by the USEPA's Office of Transportation Air Quality (OTAQ). Given the importance of the verification process, an overview of this process is provided prior to the discussion of the individual ECTs.

VERIFICATION

"Verification" is the process by which USEPA approves an emission reduction effectiveness value for a particular ECT and pollutant. Once this verification has been obtained, the end user or manufacturer is not required to conduct significant additional emission testing. This is an attractive alternative to full USEPA certification, which can cost millions of dollars in laboratory testing.

The verification process conducted by USEPA consists of reviewing data from previous emission tests, prescribing a protocol of tests and actions that the ECT manufacturer must perform, and assigning an emission reduction effectiveness value (usually expressed as a percentage reduction) for each ETC for specified pollutants and engine types. At present, USEPA has approved the verifications of two particulate ECTs (as discussed below), but no verifications have been established for NO_x or other pollutants.

In January 2000, OTAQ initiated the Voluntary Diesel Retrofit Program to encourage the timely implementation of diesel retrofits, primarily focusing on PM-10 emission reductions. Verification protocols were developed under this program not only for ECTs that reduced PM-10, but also other pollutants, such as NO_x. No protocols were drafted for public review.

In late 2000, responsibility for verification of mobile source diesel ECTs was moved to the existing Environmental Technology Verification (ETV) program, which is under USEPA's Office of Research and Development (ORD). The ETV program is a voluntary, non-regulatory program by which vendors of ECTs can establish regulatory (USEPA) approval of the actual emission reduction performance of an ECT. Emission controls for all types of sources (i.e., stationary as well as mobile sources) are evaluated under the ETV program. After receiving primary responsibility for verification of mobile source diesel engine ECTs, the ORD delegated the task of developing protocols for these ECTs back to OTAQ.

Currently, the ETV program (through OTAQ) is developing verification protocols for diesel retrofit technologies, while verification protocols for fuel-based technologies are being developed by OTAQ in their Ann Arbor office. OTAQ expects to release a draft protocol for fuel-based technologies in the first quarter of 2002. The protocols are based on ~~a~~ small volume manufacturer emission testing requirements, usually involving the Federal Testing Procedure (i.e., 40 CFR part 86 and 89, relating to diesel engine certification) and follow-up surveillance testing, as well as other technical studies.

Verification within the nonroad engine category is complicated by the different "families" of engines produced by manufacturers, and by the various operational profiles for those engines when used in different types of off-road equipment. For example, some ECTs depend on a particular temperature range for their emission reduction effectiveness. These ECTs have generally been developed for on-road applications. If such an ECT is adapted to a nonroad diesel engine that produces temperatures near the lower end of the device's operational range, the actual emission reduction effectiveness may be much lower than the product's claimed reduction efficiency**.**

As of the time of this writing, the ETV program **has not** verified any ECTs for the reduction of NO_x from diesel nonroad engines and there are only a limited number of PM-10 verified ECTs. However, these verifications can be engine type and duty cycle specific so they may not be applicable for direct use for the HNP. As previously stated, ECTs must be either verified or fully certified in order for reductions achieved by these devices to be claimed as credits in a SIP. Therefore, a tentative verification protocol and emission reduction effectiveness value for each ECT used on the HNP would have to be coordinated with OTAQ (and, through OTAQ, the ETV program) prior to claiming emission reduction credits.

It is important to note that any tentative protocols and emission reduction effectiveness values developed for the HNP could be superceded if ETV develops a protocol and assigns an emission reduction effectiveness value to an ECT after the technology's implementation in the HNP. If this were to occur, the emission reductions established for the HNP would either be higher or lower than if the emission reductions had been calculated using the new values. This would depend on whether the newly established emission reduction effectiveness is lower or higher than the tentative reduction effectiveness established for the HNP. Understanding should be sought among the parties involved in this project (i.e., PANYNJ, USACE, the USEPA, and the respective states) as to how such an occurrence would be dealt with.

State and local agencies also sponsor retrofit projects, although they are not directly involved in creating testing protocols or approving technologies. For example, many transit authorities have adopted low sulfur fuels for their bus engines. Locally, the New York City Department of Sanitation and several other city and state agencies have promoted the use of low sulfur diesel along with PM filter technology. In addition, the New Jersey Department of Transportation is conducting research and development into low- NO_x technologies for diesel engines. Although notable because they are contributing toward advances in ECTs, the emission reduction performance of these retrofits cannot be transferred to emission sources in the HNP because they are not the same engine types with a similar duty cycle.

Perhaps the most active non-federal agency in the evaluation of nonroad diesel engine ECTs is the California Air Resources Board (CARB), which has developed an emission certification process based on the California-only emission standards and signed agreements between CARB and manufacturers of engines and/or control systems. These certifications only relate to California engines and fuels. Since New York and New Jersey do not currently require the same engines and fuels as California, it is not possible to directly transfer ECTs certified pursuant to these CARB protocols. It should be noted that, in the future, CARB and USEPA may work together for a 49-state verification process (which would include New York and New Jersey), which might be examined under the ETV program.

The Northeast States for Coordinated Air Use Management (NESCAUM) was a pioneer in developing protocols for testing and approving diesel exhaust retrofit equipment. NESCAUM developed a testing protocol based on the USEPA's Urban Bus Program, and approved two technologies that have been accepted by the USEPA (which means they can be used to generate SIP-approvable emission reductions). The two technologies are an oxidation catalyst and a catalyzed particulate filter system, both of which are designed for particulate emission control. They can be used for SIP credit on any type of diesel engine, but only for particulate emission reductions. NESCAUM is no longer directly responsible for developing protocols or approving emission control systems, although NESCAUM personnel continue to be valuable resources to the USEPA and state agencies.

For additional information pertaining to NESCAUM, please refer to: http://www.nescaum.org/workgroups/vehicles.html.

For a complete list of retrofit projects in the United States, please refer to: http://www.epa.gov/otaq/retrofit/gaugewriteup.htm#assessment.

A1. DIESEL RETROFIT TECHNOLOGIES

The first category of emission control technology (ECT) is the diesel retrofit, which is an alteration made to an existing diesel engine. A number of diesel retrofit technologies have been developed, falling generally into one of the four categories discussed below. These categories are:

- Diesel oxidation catalysts
- Diesel particulate filters
- Selective catalytic reduction
- Emerging emission control technologies

It should be noted that diesel retrofit emission control technologies may be adversely affected by sulfur in the fuel. As such, it is often necessary to utilize a low sulfur diesel fuel in conjunction with a retrofit technology. Typical current sulfur levels are 3,400 parts per million (ppm) for non-road diesel and 340 ppm for on-road diesel. on-road low sulfur diesel required in the year 2006 will be below 15 ppm. In the year 2006, on-road diesel will be required to have a sulfur content below 15 ppm.

For each diesel retrofit ECT, the following parameters and/or information are provided:

- Technology name
- USEPA verification status
- General description
- Pollutants targeted
- Magnitude of emission reduction – based on either vendor's claims or actual tests (when available)
- State of development – i.e., commercially available or emerging technology (note that new emerging technologies are frequently developed; those listed below are only the ones identified during the course of this study.)
- Unit costs – actual and projected costs
- Manufacturers – a partial list of manufacturers
- Demonstration projects – list of identified demonstration projects associated with the ECT

DIESEL OXIDATION CATALYSTS

Technology name: Diesel Oxidation Catalyst

USEPA Verification Status: Final draft Generic Verification Protocol for Diesel Catalysts, Particulate Filters and Engine Modifications; Final Draft Testing Protocol. 2 October 2001.
http://www.epa.gov/otaq/retrofit/retroprotocol.htm

Description: Diesel oxidation catalyst (DOC) consists of a porous, active catalyst layer applied to a high geometric surface area, honeycomb-like structure called a substrate or catalyst support. The catalyst layer contains a small, well-dispersed amount of precious metals such as platinum. The catalyst oxidizes carbon monoxide, gaseous hydrocarbons (including VOC), and liquid hydrocarbon particles, while reducing smoke and the characteristic diesel exhaust odor.

Pollutants targeted: PM, CO, & HC

Magnitude of emission reduction: DOCs equipped on an engine fueled with sulfur levels at or below 0.05 percent sulfur have achieved reductions of 20-50 percent for PM, as well as 60-90 percent for HCs (including those HC species considered toxic) and CO, and eliminate the offensive odor coming from diesels.

State of development: DOCs are commercially available. Retrofit of DOCs has been taking place for over 20 years in the off-road vehicle sector, particularly in the underground mining industry, with over 250,000 off-road engines retrofitted. Since 1995, over 20,000 systems have been retrofitted on buses and highway trucks in the U.S. and Europe.

Unit costs: The Manufacturers of Emission Controls Association (MECA) data indicate that diesel oxidation catalysts will cost users between $1,000 and $1,800/unit depending on equipment type, horsepower and number of units being produced by the manufacturer (see Appendix A). Real life testing on DOCs, including that at the City of Houston, supports this data, however, the testing indicates that costs may be higher than projected by MECA for much larger horsepower equipment.

Manufacturers: Catalytic Exhaust Products, Engelhard, and Clean Air

Demonstration projects:

- In Sweden, over 6,500 buses have been equipped with a passive filter system.
- At the Port of Oakland (CA), diesel oxidation catalysts are being used with CARB #2 diesel (150 ppm sulfur) on yard tractors, top and side lifts. The Port of Oakland is also using diesel oxidation catalysts with ultra low sulfur diesel (15ppm) on this equipment.
- The City of Houston included a diesel oxidation catalyst in their demonstration program on smaller horsepower engines (12-80 horsepower). The demonstration noted emission reductions of 72% for NO_x and 75% for PM

<u>*DIESEL PARTICULATE FILTERS*</u>

Technology name: Diesel Particulate Filter/Trap/Continuously Regenerating Technology

USEPA Verification Status: Final Draft Generic Verification Protocol for Diesel Catalysts, Particulate Filters and Engine Modifications; Final Draft Testing Protocol. 2 October 2001.
http://www.epa.gov/otaq/retrofit/retroprotocol.htm
NESCAUM verification for Engelhard and Johnson Matthey (on-road engines only)

Description: The diesel particulate filter (DPF), also called diesel particulate trap, system consists of a filter placed in the exhaust designed to collect a significant fraction of the particulate emissions while allowing the exhaust gases to pass through the system.

Since the volume of particulate matter generated by a diesel engine is sufficient to fill up and plug a reasonably sized filter over time, some means of disposing of this trapped particulate must be provided. The most effective means of disposal is to burn or oxidize the particulate in the filter, thus regenerating, or cleansing, the filter. This is accomplished through the use of a catalyst placed either in front of the filter or applied directly on the filter, a fuel-borne catalyst, or burners which are used to oxidize or combust the collected particles. A disposable filter system has also been used. The disposal filter is sized to collect enough particulate matter for one or two working shifts of operation while remaining within the engine manufacturer's back-pressure specification; it is then removed and properly disposed.

Pollutants targeted: PM, CO, & HC

Magnitude of emission reduction: Particulate collection efficiencies of these filters are up to 90 percent or more.

State of Development: Particulate traps are widely commercially available.

Unit costs: MECA data indicate that DPF systems will cost users between $3,200-$5,000/unit depending on equipment type, horsepower and number of units being produced by the manufacturer (see Appendix A). Real life testing on DPF, including that at the City of Houston, supports this data.

Manufacturers: Engelhard, Johnson Matthey, Ceryx, Engine Control Systems

Demonstration projects:

- In Sweden, over 6,500 buses have been equipped with a passive filter system.
- DPFs have been retrofitted on heavy-duty vehicles in Great Britain, Germany, Finland, Denmark, and France.
- In Hong Kong, several hundred taxis have been retrofitted with particulate traps.
- In off-road applications, over 10,000 filter systems have been retrofitted on diesel engines over the past 10 years.
- In the U.S., diesel filter retrofit programs are underway in California and in New York City where the city plans to retrofit 3,500 buses with diesel particulate filters.

- A recent off-road equipment demonstration program conducted in Massachusetts achieved an 81 percent reduction and 96 percent reduction in PM, respectively, on two front-end loaders.

- At the Port of Oakland (CA), a demonstration project is studying the effectiveness of diesel particulate traps used in conjunction with ultra low sulfur diesel (15ppm) on yard tractors, and top and side lifts. The Port is also demonstrating the use of an active diesel particulate trap on two-yard tractors.
- The City of Houston conducted particulate trap testing in combination with diesel emulsions on several pieces of equipment in the 200 horsepower range. No testing was done on particulate traps alone.

SELECTIVE CATALYTIC REDUCTION

Technology name: Selective Catalytic Reduction

USEPA Verification Status: Protocol has not been released

Description: SCR systems are similar to DOCs except that a reductant is added to the exhaust stream in order to help convert NO_x to nitrogen and oxygen in an oxidizing environment.

The reductant in mobile source applications is normally a urea or ammonia solution. The urea solution is metered into the exhaust stream and passes through the SCR catalyst where NO_x is reduced and HC emissions and a portion of the PM emissions are oxidized.

Pollutants targeted: NO_x, HC, & PM

Magnitude of emission reduction: SCR using urea as a reducing agent has been retrofitted to vehicles providing simultaneous reductions of 75-90 percent NO_x, 50-90 percent HC, and 30-50 percent PM. SCR also reduces the characteristic odor and smoke produced by a diesel engine.

State of development: Stationary source applications for SCR are widely available. However, SCR use on mobile sources is more limited. Only recently has SCR been used for on and off-road mobile sources. Availability and effectiveness for mobile sources is limited.

Unit costs: MECA data indicate that SCR units will cost users between $10,000-$45,000/unit depending on equipment type, horsepower and number of units being produced by the manufacturer. However, real life testing on SCR, including that at the Port of Houston Authority, suggests that SCR may be more expensive than this, perhaps even twice the upper limit published by the MECA Cost Analysis. The Port of Houston Authority, for example, paid $80,000 for an uninstalled SCR unit for a 535 horsepower piece of equipment. The City of Houston will spend approximately $15,000/unit for a total of 33 SCR systems for small diesel engine (60 hp) grading equipment. There is apparently a wide variation in price for SCR units. This is due to several factors, including lower production rates among SCR manufacturers (then used by MECA's estimates; see Appendix A), and the type of equipment (horsepower, size, etc.) on which SCR will be used.

Manufacturers: Siemens, Johnson-Matthey, Klean Air

Demonstration projects:

- In the United States, a few large stationary diesel engine SCR applications are currently underway. Some of these report over 8 years of satisfactory operating service.
- At least 20 marine ocean going vessels (very high horsepower, >10,000 hp engines) have been retrofitted with SCR since the mid-1990s (according to MECA); small amount of off road applications have been demonstrated.
- Currently, over forty diesel engines have been retrofitted with SCR in Europe.
- A program conducted in Germany where 22 line-haul trucks were fitted with SCR systems achieved emission reduction targets of approximately 70 percent NO_x, 80 percent HC, and 30 percent PM. The fleet accumulated a combined 3,600,000 miles of operation, with several vehicles operating over 250,000 miles with excellent results.
- The Port of Houston conducted a demonstration project using a urea SCR on a 535 horsepower rubber-tired gantry. Although NO_x emission benefits were impressive (~80% reduction), maintenance problems associated with the SCR and emission reduction performance issues forced the Port to halt the project.
- The City of Houston conducted a demonstration project using ammonia SCR combined with a particulate trap on a 190 horsepower gradall. NO_x emission reductions were 78% and PM emission reductions with the trap were 92%. The SCR system is expected to cost $14,000/unit when larger quantities (>30) are ordered.

EMERGING DIESEL RETROFIT TECHNOLOGIES

The following are technologies that have in some cases been shown to work in select applications, but have not been developed to the point that they are commercially available on a wide spread basis. Further, none of the following technologies has been certified or verified (by USEPA) as to effectiveness.

Exhaust Gas Recirculation: An emerging retrofit strategy is the use of exhaust gas recirculation (EGR) and diesel particulate filters for simultaneous reductions of PM and NO_x emissions, as well as HC and CO emissions. The effectiveness of EGR on an existing engine is questionable, although a City of Houston demonstration project using EGR in combination with ultra low sulfur diesel (30 ppm sulfur) on 275-350 horsepower equipment achieved 75-80% NO_x and PM emission reductions. The City of Houston project, which included the use of a particulate trap, cost approximately $20,000/unit. These costs are expected to decrease drastically once EGR becomes more widespread commercially. Currently, there is no verified EGR retrofit kit.

Heat Recuperator: When combined with a catalyst, significant reductions in NO_x, PM, CO, HC emissions have been demonstrated in California.

Electronic Supercharger: Carbon monoxide and particulate matter emission reductions have been demonstrated with the electronic supercharger. PM emission reductions of 50% have been demonstrated when this technology is used in combination with diesel oxidation catalyst. Over two hundred units have been installed on urban buses in USA. The technology is also being used on heavy-duty diesel applications worldwide, including Canada, Brazil, England, and Germany.

NO_x *Adsorbers:* NO_x adsorber technology is an unproven, new catalyst technology for removing NO_x in a lean (i.e., oxygen-rich) exhaust environment for both diesel and gasoline lean-burn direct-injection engines. NO_x adsorber technology has made significant progress and is currently being optimized for diesel engine emission control. Reductions in NO_x emissions as high as 90 percent have been demonstrated in the laboratory.

A2. FUEL BASED TECHNOLOGIES

Fuel based technologies include alternatives to traditionally formulated diesel fuel that may be cleaner burning. Low sulfur diesel, which has a substantially lower sulfur content than traditional diesel, is one such fuel. Alone, low sulfur diesel results in lower PM emissions, but most importantly, when this fuel is used in combination with some of the above retrofit technologies, low sulfur diesel can offer significant NO_x, PM and CO emission reductions. Diesel emulsions are another example of a fuel-based technology that may offer emission reductions.

LOW SULFUR DIESEL

Low sulfur diesel is, as the name implies, diesel that is manufactured with substantially reduced sulfur levels. It is often produced in 30 ppm sulfur and 15 ppm (called ultra low sulfur diesel). Typical sulfur levels for standard diesel are 3,400 ppm for non-road diesel and 340 ppm for on-road diesel. A federal requirement beginning in year 2006 will mandate 15 ppm sulfur for on-road diesel.

The emissions benefits of low sulfur diesel used by itself are not substantial. For example, when formulated with higher Cetane and lower aromatics, low sulfur diesel may achieve a 5-10% NO_x emission reduction, although, PM emission reductions with this same formulation may be much higher. The real value of this fuel is the emissions benefits realized when used with some of the above-described retrofit technologies. In fact, in order for many of these retrofit technologies to function properly, low sulfur diesel must be used.

Low sulfur diesel has not been commercially available outside of California. However, several large transit fleets in the northeast US have recently contracted with Sprague Energy to supply the fuel. Sprague is providing the Connecticut Transit - H.N.S. Management with 400,000 gallons of Ultra Low Sulfur Diesel Fuel (15 ppm) for 2002. Since September 1, 2001 the clean diesel fuel, containing 95% less sulfur than conventional diesel, has been delivered to the Stanford facility for its 48 buses. Sprague also supplies the fuel to the MTA New York City Transit, State of New York, the City of New York and the Massachusetts Bay Transit Authority.

Low sulfur diesel is often sold at a premium compared to regular diesel. It is expected that higher prices for low sulfur fuel will persist until it becomes more widely available.

DIESEL EMULSIONS

Diesel emulsions, such as those developed by Lubrizol and Citgo, are a combination of standard diesel fuel, water and an additive package. These components are mixed to produce a stable, finished fuel. The water content also promotes a cloud-like atomization of the mixture during fuel injection, which improves combustion and lowers combustion temperatures, significantly reducing NO_x emissions.

PuriNO$_x$, Lubrizol's diesel emulsion, has been verified by CARB (the California Air Resources Board) for on-road vehicle use and is currently in the process of being registered by USEPA for on-road use. Registration includes a required testing process for mobile source fuels and fuel additives; it is a distinctly separate testing process from verification, which assigns potential emission reductions that could be used for SIP credits (offsets, trading, etc.). Until the on-road registration process is complete, PuriNO$_x$ may be used in on-road applications only for demonstration projects. Off-road applications are not subject to the same restriction.

Like low sulfur diesel, diesel emulsions are sold at a premium compared with regular diesel. In addition to the cost per gallon differential (in the Houston area, PuriNO$_x$ is sold for approximately 20-30 cents more per gallon than diesel), there is also a fuel efficiency penalty of 15-20% due to the water content of the fuel. Combined, these lead to a diesel emulsion cost that is approximately 35-50% higher than that of regular diesel (based on current demonstration projects).

A3. TECHNOLOGY COMBINATIONS AND OTHER EQUIPMENT ALTERNATIVES

Other potential emission reduction options include combinations of technologies described above, as well as equipment alternatives.

COMBINED EMISSION CONTROL SYSTEMS

New systems that combine catalysts, filters, air enhancement technologies, thermal management technologies and/or engine adjustments and components are emerging as retrofit options.

A combined emission control system using ceramic engine coatings combined with fuel injection timing retard and an oxidation catalyst has demonstrated over a 40 percent NO$_x$ reduction while maintaining very low particulate emissions. The system has been approved under the USEPA's urban bus rebuild/retrofit program.

Another system combines diesel particulate filters or oxidation catalysts with lean NO$_x$ catalyst technology including a heat recuperator in the exhaust stream to provide not only reductions in PM, CO, and HC emissions but also NO$_x$ emission reductions.

A system that provides substantial PM emission reductions employs a proprietary camshaft in combination with an oxidation catalyst. The system has recently been approved by the USEPA's urban bus rebuild/retrofit program but only for PM reductions.

In 1998, a 0.10 g/bhp-hr PM retrofit kit with a combined electronic supercharger and oxidation catalyst was certified under the USEPA's urban bus retrofit/ rebuild program and thus far more than 250 urban bus engines, accumulating over 5 million miles of operation, have been retrofitted with this system. These components have also been retrofitted on refuse trucks, line-haul trucks, and water tankers. In the combined system, the electronic supercharger, which exhibits minimal degradation, improves in-cylinder combustion, thereby reducing engine-out emissions to the oxidation catalyst. Visible smoke is also reduced with use of this retrofit kit.

OTHER COMBUSTION ENHANCEMENTS

Advanced fuel injection controls are common to the new generation of diesel engines, commonly being 34,000 psi, many times the pressure of older technologies. Combustion swirl, timing retard, turbo-charging, rate shaping, use of multiple valves, and electronic timing also constitute major improvements in the science. Taken along with exhaust gas recirculation, diesel manufacturers have not had to invest in exhaust after-treatment to meet TIER 2 federal non-road standards. However, it is anticipated that several manufacturers will be considering use of exhaust after-treatment to meet more stringent TIER 3 standards, largely due to USEPA's revising of its TIER 3 standards to be more stringent for PM. For a discussion of TIER 3 technologies, please refer to the follow web address:

http://www.epa.gov/otaq/equip-hd.htm

It should be noted that these combustion enhancements are being incorporated into new engines under development but are not currently feasible for retrofit to existing engines. Taking advantage of these techniques would entail re-powering equipment with new engines or replacing existing equipment with new equipment.

A4. ISSUES ASSOCIATED WITH IMPLEMENTING ECTS

When implementing ECTs into a fleet for the first time, there are a few issues that need to be addressed and planned for:

- Operability. The equipment that is going to have an ECT applied to it is required to perform tasks. An operability test should be conducted prior to actual emission testing and deployment within a part or all of a fleet.

- Verification Protocol. If the ECT has been verified by ETV, then that default emission reduction can be taken without any further testing, although this doesn't necessarily rule out required testing (for example, durability testing may be required to demonstrate that the assigned reduction continues to be achieved). If ETV has not verified the ECT, it may be possible to utilize the ECT, with close coordination with OTAQ, with the understanding that there is the potential for the pre-ETV work to be superceded if an ETV protocol is developed that has significantly different conclusions.

- Emission Deterioration Testing. Either as verification or as part of manufacturer's 25 and 75 percent useful life tests, emission deterioration testing may be required. Logistics and cost can be significant, so prior planning is essential.

SUMMARY

In summary, control of particulate emissions is currently possible using add-on control devices such as diesel oxidation catalysts and diesel particulate filters. In addition, low-sulfur diesel and diesel/water fuel emulsions present near-term options for particulate emission reductions.

With regard to NO_x emissions, the add-on devices and combustion modifications that have been discussed are further down the road in terms of development and also in terms of verification. Some of the emerging technologies may be proven feasible only on certain engine sizes and duty cycles. However, mechanisms exist to demonstrate and gain verification of technologies that can be shown to work on existing engines.

Emissions of other pollutants which are not as high in importance (for the HNP) as PM or NO_x, such as CO and VOC, may be reduced concurrently with PM or NO_x depending on the chosen method of control. For example, diesel oxidation catalysts reduce emissions of CO and VOC as well as PM, and emulsions generally reduce CO emissions along with PM and NO_x.

Review of all of these ECTs will continue, along with identification of new emerging technologies, for the duration of the HNP. The most promising of these technologies will be considered for demonstration and, if feasible, for verification as demonstrated emission reduction measures.

B. OPERATIONAL CHANGES - ENGINE RE-POWERING AND ELECTRIFICATION

Exhaust retrofit and charge air ECTs involve modifying only a part of the existing engine. For example, a catalyzed particulate filter involves cutting out part of the exhaust stack to add a device that resembles a muffler; no major engine changes are made. With engine re-powering, the old engine is completely scrapped and replaced by a new engine, or in the case of electrification, a new motor. While there are alternative fuel conversion kits for gasoline 4-stroke engines, diesel engine technology usually requires that alternative fuel "conversions" undergo complete engine re-powering. For example, combined CNG-Diesel engines may require a spark ignition system that requires a brand new cylinder head; early CNG fumigation retrofit technologies have had a dubious history because of issues relating to waste heat (melted pistons). Re-powering is an attractive alternative to retrofit ECT because the new engine will warranted over its useful life, and although it costs more in terms of capital investment, its maintenance and fuel costs can be lower when a life-cycle cost benefit analysis is used.

B1. ENGINE RE-POWERING

To reiterate, re-powering is defined as the replacement of an old engine with a new engine, but the equipment chassis remains the same. It differs from engine rebuilding, which is where an engine is built to its original configuration (and emissions). New engines are always a preferred strategy because the engine is matched to the equipment's power train and chassis. No regulatory verification is needed for engine re-powering because the emissions are fully certified by the USEPA and/or CARB. As explained below, the key is to replace older, high emitting engines with new ones that meet the most stringent certifications available from the manufacturer.

Older engines manufactured prior to 1987 are ideal candidates for re-powering projects because these engines had uncontrolled emissions. New engines that are certified to TIER 2 USEPA standards are currently being manufactured, although they are in short supply. By the year 2008, TIER 3 engines will meet even cleaner standards, although the timetable for TIER 3 implementation is questionable because USEPA intends to reopen its rules. Table 1 reports these standards in terms of NO_x emissions.

Table 1. Federal Non-Road Standards for Oxides of Nitrogen (g/HP-hr)

HP	TIER 0	TIER 1	TIER 2	TIER 3
50-99	13.0	7.8	5.6	3.5
100-174	13.0	7.8	4.9	3.0
175-299	11.0	7.8	4.9	3.0
300-599	11.0	7.8	4.8	3.0
600-749	11.0	7.8	4.8	3.0
750 +	11.0	7.8	4.8	N/a

There are many kinds of required and optional standards that apply to diesel engines, such as the USEPA's "Blue Sky" or Navistar's "Green Engine" programs, including on-road, non-road, marine, locomotive, and perhaps even recreational engines, but the concept is that going from the dirtiest to the cleanest standards will yield the greatest reductions. For the non-road category of diesel engines, TIER 0 engines were marketed before 1990, TIER 1 were before 1996, TIER 2 engines are now being phased-in, and TIER 3 engines are expected to be implemented between 2006 and 2008. Based upon a simple ratio to these standards, replacing a TIER 0 engine with a TIER 2 engine would generate a NO_x emissions reduction of approximately 60 percent.

DEMONSTRATION PROJECTS

- At the Port of Oakland (CA), replacement of pre-1996 off-road equipment with new off-road equipment meeting Tier 2 for particulate matter.
- At the Port of Oakland (CA), aqueous Diesel on existing on-road trucks (demonstration project in planning, additional CARB funding pending).
- At the Port of Oakland (CA), aqueous Diesel plus DOC on on-road trucks (demonstration project in planning, additional CARB funding pending).
- At the Port of Oakland (CA), two-stroke marine engine replacement with electronic low-emission four stroke marine engine on a tugboat.

B2. ELECTRIFICATION/ELECTRIC DREDGE

An electric dredge uses electric motors in place of diesel engines to power pumps, cranes, dredge equipment, and other mechanical equipment. The source of electrical power is either a power barge equipped with diesel engines linked to electrical generators or a shore-based electrical substation. For emission reduction purposes, the shore power option would be preferable to a power barge, because no emissions would be generated at or near the point of work. The emissions from the commercial power plant that remotely generates the electricity sent to the substation are accounted for in the power plant's own emissions permit and as a stationary source, the emissions are already reduced significantly.

An important consideration in using an electric dredge is the placement of the substation that will be needed to provide the power, if an appropriate substation is not already in place. This will require agreements between the project owner and the Power Company regarding the property to be used for the substation, as well as the cost of installation. The power line from the substation can be run to about three miles on the bottom of the waterway, which must be taken into consideration when planning the substation location.

Electric dredges are not common. There are four hydraulic type dredges that use electric pumps that have operated in Texas and California, and General Dredging has used an electric clamshell dredge on a project in California. Because of the substantial operational differences between diesel-powered dredges and electric dredges, converting a diesel dredge to run on electric power is not considered a feasible option unless the dredge is already configured to run centrally powered diesel-electric. Some clamshell and newer dredges are designed to use diesel-electric power from an adjacent power barge for their main power demands. At this time, the significant conversion issues associated with electrification have not been fully worked out. For example, to use an electric-hydraulic dredge in the NY/NJ Harbor, the dredge type would have to be federally approved prior to operation to ensure that it could meet any requirements associated with protecting marine fisheries.

Safety considerations should be taken into account when placing the power cable to make sure that ship and boat traffic will not pose a threat to the cable. Installing the cable along the bottom of the waterway should minimize the concern.

Further analysis of the feasibility of this strategy (such as regulatory requirements, costs, infrastructure, relative emission reduction, etc.) will be researched during the next six months and included in the final report.

B3. ALTERNATIVE FUELS

Engines may also be re-powered such that an alternative fuel rather than traditionally formulated diesel is used to power the equipment. Standard alternative fuels such as compressed natural gas (CNG), liquefied natural gas (LNG), hydrogen-based CNG mixtures (Hythane™), propane, ethanol, methanol and bio-diesel may offer decreased NO_x, VOC, PM and CO emissions. The major drawback associated with the use of alternative fuels is a fuel efficiency penalty, since diesel fuel offers the most energy (Btu value) in terms of mass (gallon equivalents). Gaseous-fueled systems such as CNG present fuel storage issues because so much must be stored, and LNG present safety issues because the fuel is potentially dangerous (since it is stored at minus 300 ^{0}F). Nonetheless, for certain applications where fuel storage is not such as issue, the new breed of engines (Cummins/Westport) offer dramatic emission reductions. Other examples include:

- Methanol urban buses in the South Coast Air Quality Management Area
- Garbage truck CNG re-powering
- Ford propane-powered heavy-duty trucks

Newer technologies involving alternative fuels, such as fuel cells, are promising but are several years away from being commercially developed and economically feasible.

SUMMARY

To summarize the potential operational changes under consideration, repowering offers a good opportunity to reduce emissions of all pollutants, proportional to the tightening of emission standards between an existing engine and any available new engines. This option will become increasingly more attractive as more engine types and classes are made available that meet stricter emission standards.

Use of an electric dredge with shore power would reduce dredging emissions to almost zero, although there would still be emissions from associated activities such as dredged material transport, crew transportation, and assist tug operations. In addition, there would be logistical concerns such as placement and length of the power cable. Further, there may be regulatory concerns such as the need for approval of the use of a hydraulic dredge, since almost all of the few existing electric dredges are hydraulic. As at the Port of Oakland, clamshell and excavator dredges can be electrified which may be an option for some of the dredging associated with the HNP. A feasibility study would be a prudent initial step towards electrification due to the numerous technical issues that would have to be overcome.

Alternative fuels also offer the potential for substantial emission reductions, although there would be technical challenges associated with the power levels of alternatively fueled engines (if existing engines were converted) and with the storage requirements of the alternative fuel.

Evaluation of these options will continue, particularly with regard to the availability of new low-emission engines for repowering, and the status and availability of electric dredges.

C. EMISSION CREDITS

As part of the process to explore and analyze various methods to offset emissions during the construction phase of the HNP, the feasibility of purchasing emissions reduction credits has been performed, and is described in this section. To provide the basis for this discussion, this section also includes a short discussion of conformity requirements as defined in federal regulations. In addition, Federal and State regulations pertaining to emissions offsets and emissions trading are briefly described, along with a review of these regulations to determine how these emission offsets may be employed to assure attaining general conformity. Further, this section also includes a survey of emissions trading history.

Most of the discussion presented herein focuses on NO_x emissions, since these emissions are by far the greatest ozone precursor pollutant that would be generated by the HNP. A small amount of VOCs, another ozone precursor, would also be generated. However, these numbers are not expected to exceed *de minimis* thresholds in most years.

The general processes and steps involved in trading are delineated, with added details on existing NO_x emissions credits and costs in the states of New York and New Jersey. This section concludes with a summary of the options and next steps available if the PANYNJ and USACE elect to pursue this approach.

C1. Overview of General Conformity

As previously stated, the New York and New Jersey nonattainment areas are classified as severe nonattainment for ozone, and moderate nonattainment for carbon monoxide. The County of Manhattan is additionally classified as moderate nonattainment for particulate matter (PM-10). Emissions resulting from the HNP, need to consider the *de minimis* levels for general conformity for each of the above pollutants. The general conformity trigger levels for nonattainment areas (as stipulated in 40 CFR 93 subsection 153 of the federal regulation dealing with conformity) are:

- 25 tons per year ozone (NO_x and VOC)
- 100 tons per year PM-10
- 100 tons per year CO

The initial projected baseline emissions, which are reported in the *"Marine and Land-Based Mobile Source Emissions Estimates for the 50-Foot Deepening Project"*, Starcrest, September 2001, are greater than the NO_x, VOC, and CO *de minimis* levels for several years of construction, with NO_x emissions being by far the largest emissions. Apportioned by state, NO_x emissions for New York during the proposed construction years of 2003 through 2016 range between 27 and 399 tons per year, with New Jersey emissions varying from 27 to as high as 605 tons per year in 2004.

C2. Regulations Pertaining to Conformity, Emissions Offsets and Emissions Trading

This section provides a review/summary of the federal regulations that are related to conformity. It also references and provides brief explanations of the federal and state regulations, which discuss emissions offsets and emissions trading. Table 2 summarizes the applicable federal and state regulations, which are discussed in this section.

Conformity Regulations

The USEPA promulgated the general conformity regulations at 40 CFR Part 51 Subpart W and 40 CFR Part 93 Subpart B in 1993 under the authority of the 1990 Clean Air Act Amendments (CAAA). The main purpose of general conformity is to ensure that federal actions in a nonattainment area do not hinder that area in meeting its attainment date for the National Ambient Air Quality Standards (NAAQS)

Under the Clean Air Act (CAA) and its Amendments, the USEPA set limits on the allowable pollutant levels anywhere in the United States. This ensures that all Americans have the same basic health and environmental protections. The law allows individual states to have stronger pollution controls, but states are not allowed to have weaker pollution controls than those set for the whole country. Though the CAA is a federal law, states bear much of the implementation burden. This is due to the understanding that different states have varying characteristics that must be considered, such as specific industries, demographics, geography, etc. Each state that has areas that are designated nonattainment of an air quality standard must develop SIPs (state implementation plans). These SIPs are a set of projections and commitments that describe how the states will attain air quality standards. The states must involve the public, through hearings and opportunities to comment, in the development of each SIP[1]. Any new large-scale federal project that would potentially impact air quality in the nonattainment region must demonstrate meeting conformity. In section 176(c) of the CAA, "conformity" is defined as conformity to the SIP's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards, and ensuring that such activities will not: (1) cause or contribute to any new violation of any standard in any area; (2) increase the frequency or severity of any existing violation of any standard in any area; or (3) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

Review of federal regulations concerning general conformity reveals that there are specific methods by which a project has predicted increases in pollutants greater than *de minimis* levels can meet conformity. As stated in 40 CFR 93.158(a)(1) and (a)(2), projects that exceed allowed total of direct and indirect emissions can meet general conformity in one of three ways:

1. direct and indirect emissions are specifically identified and accounted for in the applicable SIP attainment or maintenance plan; or
2. a revision to the applicable SIP; or
3. a similarly enforceable measure that effects emissions reductions so that there is no net increase in emissions of that pollutant

For this emission credit analysis it has been assumed that neither the New York nor New Jersey SIP would be revised, nor would the emissions already be demonstrated to be included in the SIP. However, there are various methods through which the third option stated above could possibly be implemented by the use of registered emission reduction credits, as outlined below.

[1] The federal government must approve a SIP. If the SIP does not meet the satisfaction of the federal government, the government can take over and prepare a Federal Implementation Plan (FIP) for that state. In that case, the new project would need to be in conformity with the FIP.

Table 2: Federal and State Regulations Pertaining to Conformity, Emissions Offset, and Emissions Trading

Federal/State	**Regulation**	**Pertinent Clauses**
Federal	Clean Air Act, 1990 Amendments	Section 176(c) – conformity
Federal	Code of Federal Regulations, Title 40- Protection of the Environment, Chapter 1, USEPA	Part 93 – Determining Conformity of Federal Actions to State or Federal Implementation Plans
Federal	Code of Federal Regulations, Title 40- Protection of the Environment, Chapter 1, USEPA	Part 96 - NO_x Budget Trading Program for State Implementation Plans
Federal	Code of Federal Regulations, Title 40- Protection of the Environment, Chapter 1, USEPA	Part 97 - Federal NO_x Budget Trading Program
New York	6 NYCRR, Chapter III Air Resources	Part 204 - NO_x Budget Trading Program
New Jersey	New Jersey Administrative Code, Title 7,	Chapter 27 Air Pollution Control, Subchapter 18, Control and Prohibition of Air Pollution from New or Altered Sources Affecting Ambient Air Quality (Emission Offset Rules)
New Jersey	New Jersey Administrative Code, Title 7,	Chapter 27 Air Pollution Control, Subchapter 30, Open Market Emissions Trading
New Jersey	New Jersey Administrative Code, Title 7,	Chapter 27 Air Pollution Control, Subchapter 31, Ozone Transport Commission NO_x Budget Program

Emissions Offsets And Emissions Trading Regulations

There are both Federal and State regulations that define the possibilities and procedures for obtaining emission offsets in general, and trading emissions credits, in particular. Parts 96 and 97 of CFR Title 40 "establish general provisions and the applicability, permitting, allowance, excess emissions, monitoring, and opt-in provisions" for NO_x Budget Trading Programs. Part 96 deals with units and sources that have been incorporated into specific SIPs, while part 97 covers the federal program and pertains to all large capacity sources, as described in subpart 4 of the regulation. Both New York and New Jersey have state regulations pertaining to the NO_x budget trading program which contain stipulations for allowable emissions trades and sales (see Table 2 above, 6 NYCRR, Ch. III, Part 204 and NJAC, Title 7, Ch. 27:31). In addition, New Jersey has two other state regulations in Title 7 of its administrative code that discus trading and offsets; Chapter 27, subchapter 18 prohibits air pollution from new or altered sources which affect ambient air quality (Emissions Offset Rule), and Chapter 27, subchapter 30 discusses open market emissions trading, which focuses specifically on discrete emission reductions (see below) for NO_x and VOCs.

C3. USE OF EMISSIONS REDUCTIONS CREDITS (ERC) TO MEET CONFORMITY

As mentioned above, the federal regulation on conformity (40 CFR 93.158) states that a project with allowable emissions exceedances can meet conformity through an *enforceable measure that effects emission reductions so that there is no net increase in emissions of that pollutant*. Part of the purpose of this statement was to fulfill the spirit of the regulation (i.e., no net emissions increase would be beneficial to the air quality environment). Enforceability was also a key term added to the regulation, in order to ensure that any projected reductions must be real, with a defined, responsible mechanism to ensure that such conditions will occur. This section outlines how the purchasing of emission reductions credits could result in real emissions offsets for the project and discusses the following topics: tradable emission markets, ERC and DERs, and trading/purchasing ERCs/DERs.

Tradable Emissions Markets

The proposed HNP would result in total construction related emissions (for the combined operations in New York and New Jersey) on the order of 400-950 tons of NO_x per year over a 10-year period. In other years (near the immediate start and near the end of the project), the projected construction emissions would be less. NO_x is a precursor to ozone, which is problematic throughout the Mid-Atlantic and Northeast. In these regions there are many areas that do not conform with the national ambient air quality standard for ground level ozone. The confluence of nonattainment areas has complicated efforts. Potential air quality improvements in one state are hampered as ground level ozone and its precursors generated in other regions transport across state lines. To address the problem of ground level ozone and its transport, congress established the Ozone Transport Region (OTR), which included twelve states from Virginia to Maine and the District of Columbia as part of the CAA Amendments of 1990.

To achieve reductions in the most cost-effective manner, the Ozone Transport Commission (OTC) developed a model rule for a cap and trade program to take advantage of market efficiencies. The NO_x cap and trade program allocated NO_x allowances to each state based on 1990 statewide emissions. The states then allocated their budget of allowances to all of the affected sources in their state. Affected sources included all fossil fuel fired boilers or indirect heat exchangers with a rated capacity of 250 million British Thermal Units (MMBtu) per hour or more; and all electric generating facilities with an output of 15 megawatts or more.

Each allowance permits the owner to emit one ton of NO_x over the course of the ozone season (June, July, and August). The NO_x Budget Program establishes a market for these allowances. It enables market participants to buy and sell allowances. The trading component of the NO_x Budget Program can result in substantial savings over the "command and control" model of environmental regulation that is traditionally used. Trading enables each affected source to compare the costs of the full spectrum of NO_x control options. Each emitter has an opportunity to choose the least-cost solution for each facility or system. Some affected sources will choose to generate surplus allowances by retrofitting equipment with control technology, fuel switching or decreasing throughput to sell them on the open market. Other facilities with higher marginal cost of NO_x emission reductions will purchase these allowances because it is the most cost-effective alternative.

ERCs And DERs

There are two main types of tradable allowances - emission reduction credits (ERCs), which are available in both New York and New Jersey, and discrete emission reductions (DERs), which are available in New Jersey but not in New York. ERCs, quantified in tons per year, represent pollution that is no longer being emitted. A company that has retained the right to emit a given quantity of a pollutant into the air, but has voluntarily lowered or eliminated those emissions may apply to have those emissions certified. Once certified, the emissions may be used to meet the requirements of a different facility.[2] ERCs are the traditional and more widely accepted credit system for the use of offsets for new sources of emissions.

Both VOC and NO_x from facilities in areas that are nonattainment for the pollutant in question can be reduced and certified to obtain ERCs. Usually, the emission reductions must have occurred within the past 5 years and must be in excess of what is otherwise required by regulations.[3] There are many types of emission reductions that qualify for ERCs (see below). Facilities that do not have ERCs to offset emissions from planned expansions must purchase ERCs from other sources. This creates an ERC market, with supply and demand determining the value of the ERCs.
An ERC can be created by:

- Shutting down all or part of a facility;
- Curtailing production or operating hours;
- Improving control measures (i.e., lowering emission rates through technology or fuel changes); and,
- Making other process changes that result in permanent emissions reductions.

[2] In order to legally certify the ERCs, the facility that has reduced the emissions must agree to a permanent reduction in its air permit.

[3] This fact becomes problematic as regulations change. ERCs resulting from a voluntary process change lose their value when that change becomes regulated. Therefore, ERCs resulting from process changes and/or improved control measures are worth less that those obtained from shutdowns, as the first group carries the danger of being devalued or even eliminated.

DERs, are similar to ERCs, except that they are expressed in tons and do not carry over to subsequent years. The types of emissions reductions that qualify for DERs include short-term improvements, such as alternative fuel use or temporary production curtailments. One DER credit is equal to one-twentieth (1/20) of a ton[4]. A credit that has been bought can be used only once. In addition, a purchaser may use only 90% of the DERs it acquires; 10% of the DERs cannot be used and must be "retired" for the benefit of the environment. As such, every use of DERs results in a reduction of emissions. Some states will allow DERs to be used as new source offsets if a five to ten-year supply can be acquired. New Jersey sources have been trading DERs for several years, but New York has not. For a project such as the HNP where construction emissions will be consistent for over a 10 years period, DER may not be the most prudent or viable strategy for emissions offset.

In addition, there is much opposition to the DER trading program and governmental agencies have recently been questioning its environmental integrity, claiming that if short terms reductions can be achieved, short term increases are likely and therefore the reductions should not be credited. As noted above, ERC trading is more established and more accepted.

Information on ERCs and DERs is publicly accessible. The NYSDEC, Bureau of Stationary Sources maintains a registry of ERCs that are available for offsets pursuant to the New York State Clean Air Compliance Act and 6NYCRR Subpart 231-2. A list is provided in Appendix B. In New Jersey, the registry is not currently on the web, but the NJDEP and/or any of many environmental brokers, will provide information on both ERCs and DERs via telephone.

One of the potential problems associated with using emissions credits for emissions offsets in the HNP is that while DERs can be bought from either stationary or mobile sources and then used for either source type, this has not been the historical case for ERCs. ERCs, as described in the state regulations for both New York and New Jersey, refer to credits resulting from stationary sources, and as such, are readily available for use by stationary sources. The use of these credits for offset of emissions from construction related activities is not discussed explicitly in the regulations, and as of yet, there is no precedent for such use in this region. In other areas, such as in Texas's new regulations, have been promulgated which explicitly provide for reciprocity between mobile ERCs (MERCs) and stationary ERCs (TNRCC, Chapter 101, Subchapter H: Emissions Credits and Banking). Though much of the construction equipment for this project are most often considered non-road mobile sources, the construction and related vessels would be working only in the NY/NJ Harbor for the duration of the project. For major sources of NO_x (i.e., dredges), their activities would render characteristic that are similar to those of stationary sources. An analogy could be made to lifting cranes for barge loading. The USEPA is currently addressing the issue of whether lifting cranes that load and unload barges on the dock are considered stationary sources. As with the dredges, though they are technically mobile, they

[4] This applies to both NOx and VOC DERs, as defined in NJAC, Title 7, Ch. 27, SCh 30.

would be stationed in the same relative location for years at a time, resulting in emissions patterns characteristic of a stationary source.

Trading/Purchasing ERCs And DERs

Emissions reductions credits are bought and sold just like any other commodity on the market. Credits are categorized by state and nonattainment area and must be purchased accordingly. For example, to obtain credits for a project in a severe nonattainment area in New York, credits must be purchased from a severe nonattainment area in New York. Due to the regional effects of ozone, many states in the Northeast region have signed reciprocity agreements. Credits that are then needed for use in one state can be bought in another. There is currently no precedent for reciprocity between New York and New Jersey, though due to the nature of the nonattainment area spanning regions in both countries, there are no foreseeable barriers to reciprocity for sources located in different states, but in the same nonattainment area.

As with most commodities, the transaction is facilitated by a broker. As emissions have become a hot commodity in the past few years there are many brokers that specialize in emissions trading and sales. Broker can represent both buyers and sellers. To put a "credit" on the market, it must be certified by the state agency, pursuant to federal guidelines. This is done through the submittal of forms, which specify the reduction and guarantee that it is real and permanent. Brokers can also aid in the certification of emissions credits. Brokers help identify appropriate available credits as per the need of the buyer and then, based on recent market activity and market trends negotiates a price acceptable to both the buyer and the seller. Once the agreement is signed, the broker reports the transaction to the state agency for follow up and enforcement purposes. A list of brokers can be found on the USEPA website:

http://www.epa.gov/airmarkets/trading/buying.html

C4. NEW YORK EMISSION CREDITS

In New York State, companies are currently buying and selling NO_x and VOC ERCs within the Region 2 nonattainment area. Based on information supplied by brokers, there are approximately 1,000 currently available certified NO_x ERCs, most of which are owned by Con Edison (see Appendix B). The Port Authority recently obtained control of 202.9 credits (tons per year) from the Procter & Gamble Port Ivory facility. Market prices for New York State emissions that were in the range of $10,000 - $12,000 per ton[5] in severe nonattainment areas in November 2001 jumped to approximately $15,000 per ton in December 2001. This sharp increase in price (from around $6,000 - $7,000 in May 2001) may be due to the recognized shortfall of power distribution in the New York City region (and thus the anticipated need for such credits to offset new sources), as well as the limited number of credits available for

[5] As mentioned before, ERC units are in tons per year. Once the tons are owned, they continue to be valid year after year. Once they are no longer necessary, they can be sold.

purchase.[6] In severe nonattainment areas, ERCs are typically bought to offset emissions for new stationary sources of air pollution at a ratio of 1.3:1. For example, to offset 100 tons per year of new emissions, the equivalent of 130 tons of ERCs must be purchased. A sample purchase agreement for the purchase of ERCs is provided in Appendix C.

C5. NEW JERSEY EMISSION CREDITS

In the New Jersey area, companies are buying and selling both DERs and ERCs. Though there is no publicly published list of the DERs or ERCs available in New Jersey, data gathered from environmental brokers[7] puts the available ERC NO_x stock at around 3,000 credits and the DER stock at approximately 1,000. However, most of the ERCs are from facility shutdowns in New Jersey in the 1990s, which, according to the regulations, become discounted by 50% after five years and expire after 10 years. 90% of the available New Jersey credits expire in April 2003 (i.e., they are removed from the market trading program). These ERC credits are much cheaper than their New York counterparts, running approximately $1,500 - $2,000 a ton for credits from factory shutdowns. The DERs sell for approximately $1,100 per ton, but as mentioned above, these credits can be used only once, and may not be suitable for this project.

C6. OPTIONS AND NEXT STEPS

This section has discussed the option of obtaining emission offset in the form of reduction credits to assist the HNP reach a conformity determination. The implementation of this option could result in real emissions reductions, though the procedures for ensuring it as an enforceable mechanism would need to be analyzed further. The purpose of the 1990 CAAA and the necessity of a project to meet conformity requirements are to ensure that regional ozone precursor emissions are accounted for and reduced in order to maintain and improve ambient air quality standards. Any offsets that result in real and enforceable emissions reductions, therefore, should be considered. Emission reductions that have been properly certified and are available for purchase represent such real reductions. Obtaining these credits and taking them off the market, though not explicitly stated in the regulations and perhaps not envisioned in the original development of the legislation, could be considered as an enforceable measure. The purchase and commitment of ERCs to offset construction emissions from the project could in effect result in no net increase in pollutants (either by this action alone or in conjunction with other emission offsets), as required by the conformity regulations. As mentioned, once emission credits have been obtained they are valid year after year. Therefore, ERCs may be needed to cover the quantities necessary for the projected worst years. For New York, maximum NO_x emissions have been projected for 2009 at 398.9 tons. One possible option to help offset the New York emissions is the Port Ivory credits at 202.9. For

[6] Con Edison, the owner of about 70% of the available credits, has not been selling many credits recently.

[7] Three broker firms were consulted: Natsource, Evolution Markets, and Cantor Fitzgerald EBS.

New Jersey, 2004 is the year with greatest NO_x emissions predicted at 605.2 tons. These quantities are currently available for purchase. Additionally, these quantities represent the worst year and would not need to be used during other years, which could result in total lowered emissions for the region. At the end of the construction process, the credits can be put back on the market. However, the enforcement mechanism and agreement for the process would still need to be agreed upon.

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APPENDIX A

Independent Cost Survey for Emission Control Retrofit Technologies: Report of Agreed-Upon Procedures
Manufacturers of Emission Controls Association

Costs

Most predictive cost models for engine re-powering, fuel usage, and retrofits are order-of-magnitude at best, and must be interpreted with caution. Traditional models developed by the USEPA deal with costs in terms of dollars per ton reduced. Reasonably Available Control Technology is supposed to be below $10,000 per ton of a criteria pollutant in 1990, but has now risen to about $13,000 per ton. Several State grant programs have these limitations (California *Carl Moyer Pro*gram and the *Texas Emission Reduction Program*), since investing more than $13,000 per ton would yield few reductions for a relatively high investment cost. Please note, the $13,000 dollar value is more a screening method than real economic science.

The following information has been provided by the Manufacturers of Emission Controls Association (MECA). Please be aware, the projected cost information is current as of December and generally reflects ECTs for PM, although some work on selective catalyst reduction (SCR) for NO_x reductions is also provided.

MECA Independent Cost Survey for Emission Control Retrofit Technologies

Oxidation Catalysts

Engine Size (hp)	Yearly Sales Volume	Mean Cost to User $ Muffler Replacement	In-Line
100 - 200	500	1,250	575
	1,000	1,200	563
	5,000	1,100	463
	10,000	975	425
201- 300	500	1,650	850
	1,000	1,600	825
	5,000	1,400	725
	10,000	1,225	650
301- 500	500	1,750	1,150
	1,000	1,700	1,125
	5,000	1,550	1,000
	10,000	1,375	900

Two-Stroke Scaling Factor: None or N/A
Nonroad Scaling Factor: None or N/A

Diesel Particulate Filters

Engine Size (hp)	Yearly Sales Volume	Mean Cost to User $ Muffler Replacement	In-Line
100 - 200	500	4,500	4,000
	1,000	4,400	4,000
	5,000	4,000	3,500
	10,000	3,250	3,000
201 - 300	500	5,000	4,000
	1,000	4,900	4,000
	5,000	4,500	3,500
	10,000	3,750	3,000
301- 500	500	5,500	4,000
	1,000	5,400	4,000
	5,000	5,000	3,500
	10,000	4,250	3,000

Two-Stroke Scaling Factor: None or N/A
Nonroad Scaling Factor: None or N/A

SCR

Engine Size (hp)	Yearly Sales Volume	Range of Costs to User $
100 - 200	500	17,500 - 40,000
	1,000	15,000 - 35,000
	5,000	12,500 - 30,000
	10,000	10,000 - 15,000
201- 300	500	18,000 - 45,000
	1,000	15,500 - 40,000
	5,000	13,000 - 35,000
	10,000	10,500 - 18,000
301- 500	500	18,500 - 50,000
	1,000	16,000 - 45,000
	5,000	13,500 - 40,000
	10,000	11,000 - 20,000

Two-Stroke Scaling Factor: N/A
Nonroad Scaling Factor: N/A

APPENDIX B

Available Certified New York NOx Emission Reduction Credits for USEPA Region 2

APPENDIX C

Agreement for Purchase of Emission Reduction Credits